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ABSOLUTE DETERMINATION OF THE AMPERE

An important development of modern physics has been the establishment of a uniform system of units for all branches of physical measurements. The electrical units, a part of this system, were originally so defined that the unit of energy would be the same in the electrical system as in the mechanical system, and that the magnetic permeability of a vacuum would be unity. In order to insure that the units in actual use shall conform with the definitions, it is necessary to make absolute determinations of them; that is, to measure the electrical units in terms of the units of length, mass, and time.

In RP685 in the June number of the Journal of Research, there is described a determination of the absolute value of a current undertaken at the Bureau to find whether any changes had occurred in the electrical units in everyday use since the last absolute determination. A number of modifications of the former apparatus were made and the greatest care was exercised to insure that the result would be of the highest precision. A progress report on this work was published in Technical News Bulletin No. 192 (April 1933). The final calculations show that no appreciable change has occurred since the determination of 20 years ago.

HEATS OF COMBUSTION OF ETHANE, PROPANE, NORMAL BUTANE, AND NORMAL PENTANE

Because of the dearth of information concerning the heats of combustion of ethane, propane, normal butane, and normal pentane, and because of the pressing need in industry and in the sciences for this information, the thermochemical laboratory of the Bureau has made measurements of the heats of combustion of these gaseous normal paraffin hydrocarbons.

Accurate values for these constants are needed for the following reasons: First, ethane, propane, and butane are

becoming increasingly important as fuel gases in industry and in the home; second, for these substances, values of the free energies of formation, which are needed for computing chemical equilibria in which these gases take part, can be determined accurately only from the relation between their entropies and their heats of formation, which latter values are calculated from the heats of combustion; and, third, accurate values for the heats of combustion of the normal paraffin hydrocarbon gases will give data from which may be drawn information concerning the energies of the atomic linkages in these molecules.

The existing data on the heats of combustion of ethane, propane, butane, and pentane are very meagre and, according to present-day standards, exceedingly uncertain. For ethane and propane there are the discordant values of Thomsen and of Berthelot and Matignon, who used the calorimetric equipment available half a century ago and who did not have pure gases to work with. For normal butane there are no data on the heat of combustion recorded in the literature. For normal pentane, there exists the value obtained by Roth and Machlett, who published no report of their experiments but gave simply the numerical result.

The values obtained in the present investigation for the heats of combustion of these gases are estimated to be accurate within ±0.022 to ±0.028 percent. The existing "best" values for the heats of combustion of these gases differ from the values obtained in the present investigation by the following amounts: Ethane, —1.23 percent; propane, —0.87 percent; normal butane, no existing data; normal pentane —0.86 percent. These differences are from 30 to 50 times the estimated uncertainties in the values from the present investigation. A complete description of this work will be found in the June number of the Journal of Research (RP686).

CAUTIONS REGARDING GAS APPLIANCE ATTACHMENTS

Many gas appliance attachments, such as "gas savers", attachable solid tops, water backs, flue obstructors, "grease absorbers", and "burner protectors" are being sold to the public. Most of these are sold at the door by agents, many of whom make extravagant claims regarding the merits of their wares. Such claims as 30-percent reduction in gas bills and elimination of all grease and dirt are quite common.

The Bureau has tested a number of such accessories and a short time ago issued Letter Circular No. 397 on this subject. The demand for this was so great that it has been replaced by a regular printed publication, Circular No. 404, which is now available from the Superintendent of Documents, United States Government Printing Office, Washington, D.C., at 5 cents a copy. The data in this circular may be summarized as follows:

All of the "gas savers" and attachable solid tops tested affected the operation of a range in such a way as to increase the tendency to form carbon monoxide, a gas which, even in very small amounts, is injurious to health. This gas was actually produced as the result of the use of most of these devices on appliances which were otherwise safe when normally operated. None of the attachments tested appreciably increased efficiency; on the other hand, some of them considerably increased the amount of gas required for a given purpose. This indicates an increase rather than a decrease in gas bills.

The "burner protectors" keep the burners clean, but do so at the expense of cooking efficiency. None of the water backs tested have proved satisfactory. Some of them caused the formation of carbon monoxide and all adversely affected efficiency.

The flue obstructors tested created extremely hazardous conditions when placed in the flues of such appliances as gas ranges and water heaters. These devices are intended to increase the efficiency by reducing the size of the flue opening and thus preventing the escape of some of the heat up the chimney. The danger of the indiscriminate use of such devices arises from the fact that most appliances designed to burn gas are already equipped with flue openings which are as small as they can be made with safety. Any further reduction, therefore, affects the combustion of the gas, and the formation of carbon monoxide results. This statement does not necessarily apply to home-made or specially constructed appliances or to appliances designed to use other fuels but "converted" to use gas, some of which should have the area of the flue passages reduced. This adjustment should be made by a workman of undoubted competence who is fully responsible for the continued good performance of the appliance.

The "grease absorbers" should be called grease diffusers, because they merely distribute the grease more uniformly around the kitchen. Those that are filled with steel wool or other material in such a way as to obstruct the passage of the flue gases may become dangerous.

A number of different devices which are designed to be placed in the gas piping between the gas meter and the gas appliances have been tested. These are all claimed to save gas for one of several reasons, such as that they "atomize the gas" or that they "eliminate stratification of the gases in the pipe." There is only one thing which any of these attachments can do and that is to reduce the amount of gas which can flow through the gas pipe under a given pressure. If it is necessary to reduce the flow of gas to a given appliance or to one of the burners on an appliance, the proper place to make such a reduction is at the appliance or burner orifice. Such an adjustment is easily made, does not require the opening of the gas line, and does not affect the supply of gas to other appliances which may be properly adjusted.

Gas pressure regulators are sometimes offered in conjunction with a maintenance service on a rental basis. Every gas company is under obligation to maintain satisfactory conditions of pressure at every customer's premises. If such conditions cannot be maintained except with the aid of a regulator, the gas company should install one and pay for it. In any event it is desirable to ascertain the cost of a regulator purchased outright through a local gas fitter or other established dealer before renting one from a canvasser.

It may be stated as a general principle that the greatest care should always be exercised in using any attachment that has not been manufactured by the maker of the original gas appliance for that particular purpose, because its use may create a hazard where none existed before.

REACTION PRODUCTS OF WATER AND CALCIUM SILICATES

An understanding of the nature of setting of Portland cement requires a knowledge of the products of the reaction between water and the calcium silicates (beta-dicalcium silicate, tricalcium silicate) which are among its major constituents. This in turn necessitates information concerning the equilibrium relationships of the system CaO-SiO_2-H_2O, upon which surprisingly little work has been done despite the direct bearing of the system upon soil equilibria and certain geological phenomena.

Therefore, the solubility of silica at 30 C. in solutions containing increasing concentrations of calcium hydroxide up to saturation was studied, together with the compositions of solid phases of combinations of lime, silica, and water, capable of existing in equilibrium with the solutions. Correlation of analytical data with an electrometric study of the extent of combination of lime and silica in the solutions indicated that compounds belonging to the system CaO–SiO_2–H_2O at 30 C. may be hydrated calcium salts of orthosilicic acid. The ionization constants for the 4 steps in the dissociation of orthosilicic acid were calculated from the experimentally found hydrolysis constants of its salts and the following values obtained:

$$K_{a1}=2.2\times10^{-10},\ K_{a2}=2.0\times10^{-12},$$
$$K_{a1}=1\times10^{-12} \text{ and } K_{a4}=1\times10^{-12}$$

The solubility of silica in solutions containing calcium hydroxide is greatest when hydrated silica is in contact with the solutions and decreases rapidly as the solid phase is converted to increasingly basic hydrated calcium silicates.

These results provided the background for a study of the reaction of water upon the following anhydrous compounds of the binary system lime-silica: Monocalcium silicate, tricalcium disilicate, gamma- and beta-dicalcium silicate, and tricalcium silicate. It was found that the hydraulic properties of these compounds are intimately related to their capacity to form metastable solutions which precipitate hydrated calcium silicate of compositions determined by the equilibrium relationships of the system CaO–SiO_2–H_2O. Monocalcium silicate, known to be nonhydraulic, does not form metastable solutions but the other anhydrous calcium silicates do, this tendency increasing with an increase in the basicity of the silicate. A study of the reaction of water upon portland cement indicated that the calcium silicates therein were converted largely to hydrated calcium orthosilicate by the same mechanism and that this compound is probably present in set cement.

The reaction between lime solution and diatomaceous silica is essentially the reverse of the reaction of water

with anhydrous calcium silicates, for the diatomaceous silica removes lime from solution and fixes it in chemical combination in the solid phase. An investigation of this reaction and of the reaction between silica gel and lime solution in relation to the equilibrium diagram is also included in RP687 in the June issue of the Journal of Research.

DETERMINATION OF BORIC OXIDE IN GLASS—A MODIFIED METHOD

The routine determination of boric oxide in glass by the Chapin method is somewhat laborious, particularly for control purposes. The following method has been found satisfactory without material sacrifice in accuracy. Decompose 0.5 g of glass by fusion with 1 g of sodium carbonate. Digest the fusion with water, cool, acidify with hydrochloric acid (1:1) using para-nitro-phenol as indicator. Add 1 ml strong hydrochloric acid, transfer to graduated cylinder, and make volume up to 25 ml. Add 25 ml absolute alcohol and 50 ml ethyl ether and shake thoroughly. Let the mixture stand until the ether layer is separated, transfer 50 ml of the ether layer to a small flask, add 2 drops para-nitro-phenol and neutralize with half normal sodium hydroxide. Add 1 ml phenolphthalein and additional sodium hydroxide to a definite pink, and then twice the last amount of sodium hydroxide in excess. Remove all the ether and alcohol, first by careful evaporation and finally by vigorous boiling. Cool, dilute to about 35 ml and just acidify with half normal hydrochloric acid. Then proceed with the titration of boric oxide by the usual method.

The amount of boric oxide found in the 50 ml aliquot must be computed to that in the total ether layer and the latter has been found to be 51.2 percent of the total boric oxide in the sample taken.

IODINE NUMBER OF WOOL

The term "iodine number" is ordinarily associated with oils and fats for which it serves as a measure of chemical unsaturation. It represents the number of centigrams of iodine which combine with one gram of material.

The aliphatic amino acids are saturated compounds, but they exhibit definite and reproducible iodine numbers which may de determined by the same methods as those used for fats and oils. The experimental evidence indicates that the iodine number of such substances is not due to ordinary unsaturation but is related to the free amino nitrogen content. The iodine reacts only with the free amino groups in these compounds, unless, like cysteine, for example, they contain readily oxidizable groups which also react. The iodine numbers of proteins may be determined in the same manner and a part, at least, of the iodine number of each protein may be attributed to the reaction of iodine with the free amino groups.

The purpose of a research described in the Journal of Research for June (RP689), was to find a method for determining the action of various chemical reagents upon wool. The determination of the iodine number provides a useful means of determining the extent to which the amino groups are affected by various treatments of the protein.

The iodine numbers of some typical proteins are reported and a general correspondence between the iodine numbers and the isoelectric points of the proteins is shown.

Conversion of amino groups to hydroxyl groups, combination of amino groups with strong acids, and other chemical reactions which affect the amino groups reduce the iodine numbers of amino acids (with the exception of cysteine) to zero.

Part of the iodine number of wool is shown to be due to cysteine which is very susceptible to oxidation. The iodine number of wool is therefore affected by reactions of chemical reagents with the amino or the cysteine groups.

This method will distinguish, for example, between reversibly adsorbed and chemically combined acid. The latter can be removed by the action of an alkali and this restores the original iodine number of the wool.

BRAILLE PAPERS

Blind readers of Braille process printing are not troubled with the sort of paper and printing variables that are of well-known importance to visual readers of ordinary ink printing, but the results of a study of Braille papers made recently at the Bureau and reported in the June Journal of Research (RP690), indicate that they too have problems. The sensitive fingers of blind readers are as much irritated by poor quality of the raised dots forming the symbols read by the finger tips, as the eyes of visual readers are fatigued by distressing show-through of printing or

glare from excessive paper gloss. The Library of Congress recently requested the assistance of the Bureau in finding a quality standard that could be relied upon to ensure uniform, high-quality books for the blind readers.

When the study was initiated, many types of papers were in use by commercial Braille process printers. No accurate information on paper qualities essential to good Braille printing quality was available, and an extensive study of a wide variety of papers in use and the quality of printing obtained with them was necessary. Some of the papers were too hard and the raised dots printed on them had harsh cracked surfaces irritating to the reader's fingers. Other papers were too soft and the dots were not strong enough to prevent them from being deformed under the reader's fingers. Still other papers had insufficient strength to withstand repeated handling. By correlating paper properties with quality of printing, a relationship was found between the tensile properties of paper and strength of the raised dots. The density of the paper was very important in its relation to reading quality of the dots. The paper requirements for uniformly high quality Braille process books for the blind were determined and incorporated in the quality standard for the Library of Congress.

FRICTIONAL RESISTANCE OF STEEL AND BRASS IN SHRINK FITS

The familiar property of expansion and contraction with rise and drop in temperature of metals is frequently utilized in binding a shaft or pin in a collar or socket by a shrink fit. With most metals, an oversize of the shaft of one or two one-thousandths of an inch per inch of diameter can be accommodated by heating the encircling member before the two are assembled. The converse method of contracting the pin or shaft by cooling it in liquid air or "dry ice" has received only brief mention, probably on account of the supposed commercial impracticability of the operation. The widespread availability of solid carbon dioxide as an easily transported refrigerant has put this method on a more practicable basis.

As described in a paper by W. H. Swanger at the June meeting of the American Society for Testing Materials, some work was recently completed at the Bureau on the axial slip or shrink fits made by cooling 1-inch diameter cylindrical pins to —80 C (—112 F) in dry ice and inserting them into rings which were about 0.0015 inch smaller than the pins when both were at room temperature. Three combinations of pin and ring were used; a brass pin and brass ring; a brass pin and steel ring; and a steel pin and steel ring. The maximum resistance to axial slip developed after a small amount of initial slip was 1,430 lb/in.^{2} of contact area in the all-brass unit and 6,050 lb/in.^{2} of contact area in the all-steel unit. The higher resistance in the steel unit was due chiefly to the fact that seizing between pin and ring occurred to such an extent that particles of steel were torn bodily from the pin. In the brass unit no such seizing occurred. The maximum resistance developed between the steel ring and brass pin was 2,199 lb/in.^{2} of contact area, and the pin was visibly scored by the steel ring.

WEAR OF METALS

A series of metal-to-metal wear tests of plain carbon steel has recently been completed in which were duplicated the testing conditions which led Fink, in Germany, to conclude that the presence of oxygen was essential to appreciable wear of metals. In the present series of tests, little or no difference was observed in the rates of wear of the steel whether tested in hydrogen, in nitrogen, or in air.

It was further observed that under conditions permitting the formation of a slight oxide film on the wearing surfaces the rate of wear was relatively low, whereas under conditions which did not permit oxide film formation the loss by wear was relatively very great. That is, oxide films may reduce the rate of metal-to-metal wear of steel appreciably while the absence of any oxygen on the surface may result in excessive wear.

EFFECT OF SURFACE FINISH ON INITIAL CORROSION OF STEEL UNDER WATER

It is well known that the surface of certain metals, such as iron, steel, aluminum, zinc, and copper, is coated with an oxide film, which is oftentimes invisible if it is thin and closely adherent to the metal. The existence of such coatings has been established by several investigators. Coatings of this kind may protect the metal from further oxidation by preventing the diffusion of more oxygen. On the other hand, they may cause irregular-

ities in the results of corrosion tests, especially if there are discontinuities in the oxide film. Such defects may be: (*a*) Breaks caused by the expansion or contraction of the metal or by its being bent or scratched, (*b*) "weak spots" produced by inclusions in the metal at the surface, or (*c*) a break-down of the oxide film in certain solutions.

The effect of an oxide film present on the surface of a low-carbon steel finished with various abrasives upon the initial corrosion rate in water flowing at different velocities (5 to 225 feet per minute) was studied recently at the Bureau. The results of this investigation were given in a paper, "Observations on Effect of Surface Finish on the Initial Corrosion of Steel Under Water" by Leo J. Waldron and Edward G. Groesbeck, at the meeting of the American Society for Testing Materials this month.

MICROSCOPIC EXAMINATION OF STEELS AT HIGH TEMPERATURES

Several years ago an apparatus was developed at Harvard University by Dr. B. A. Rogers, now a research associate at the Bureau, which permitted the direct observation of the microstructure of iron at high temperatures, even up to the melting point of the metal. This apparatus is now being applied to the study of the austenitic grain size in carbon tool steel in one of the current research projects at the Bureau.

While it is possible to maintain a bright, clean surface on a specimen of pure iron in this high-temperature metallographic microscope by passing hydrogen through the enclosed specimen chamber, it is not permissible to use hydrogen when the specimen under examination is carbon tool steel because of the rapid loss of carbon caused by the hydrogen. The examination of the carbon steels is being carried out in an atmosphere of mixed CO and CO_2 and in an atmosphere of helium.

"SHATTER" CRACKS IN RAILS

Residual stress measurements have been completed on 8-inch lengths from each of two rails from the same ingot, one cooled normally after rolling and the other cooled slowly through the blue heat temperature range by a recently developed industrial process. Six longitudinal specimens, one-half inch square in cross section, were cut from the head, web, and base of each of the 8-inch pieces. The bars from the center of the head of the normally cooled rail increased in length when isolated from the head, whereas similar bars from the slowly cooled rail decreased in length. The head of the normally cooled rail contained numerous shatter cracks, but the slowly cooled rail was free from shatter.

The results are interpreted as indicating that tensile stresses are normally produced in the central part of the head of a rail as it cools, and that in the shattered rail these stresses were relieved when the shatter cracks formed.

INTERNAL STRESS IN AIRPLANE TIE RODS

Recent tests in the Bureau's metallurgical division have indicated that internal stresses set up by rolling, in 1,050 carbon steel tie rods for airplanes, can be very largely removed by heating 30 minutes at 600 to 700 F. This heat treatment does not lower the mechanical properties of the material very materially. In stainless steel tie rods, about 50 percent of the internal stress can be removed by heating 30 minutes at 900 F. After this treatment the mechanical properties are considerably higher than in the "as-received" condition.

After heating at a temperature of 900 to 1,000 F, however, the resistance to corrosion, as shown by the boiling-nitric-acid test, decrease sharply. The temperature control in heat treatment of this material would therefore have to be very carefully controlled to obtain an appreciable relief of internal stress without impairing the corrosion resistance. It is probable that the presence of titanium or columbium often recommended as a "stabilizer" in the stainless steel may allow higher temperatures to be used.

THE PREECE TEST FOR ZINC COATINGS

Steel coated with zinc, known as "galvanized steel", is extensively used where protection against atmospheric corrosion is required, for example, on roofings and gutters, fences, screens, hardware, and marine fittings. The zinc coatings may be applied by different methods, including: (*a*) Hot-dipping, in which the steel is dipped into molten zinc; (*b*) galvannealing, in which the hot-dipped coatings are subjected to heat treatment; (*c*) sherardizing, in which the steel is heated in zinc dust; (*d*) electroplating (also known as "electrogalvaniz-

ing") ; and (*e*) spraying, in which atomized zinc is applied to the metal surface.

In all cases the useful life of the coated steel depends largely on the thickness of the zinc coatings, especially at the thinnest places. It is therefore desirable to have a method of inspection which will reveal the minimum thickness of the zinc coating. The Preece test has long been used for this purpose. In this test the zinc coated article is dipped into a solution of copper sulphate for successive periods of 1 minute each, with intermediate removal of loosely adherent copper until a firmly adherent deposit of copper is produced on appreciable area. The specimen is then reported as having withstood a certain number of "dips" in the Preece test. This method is widely used, although erratic results are sometimes obtained. The purpose of a recent study with zinc coated wires, described in RP688 in the June Journal of Research, was to find the cause and remedy for such difficulties.

It was found that the copper sulphate solution must be carefully neutralized, preferably with copper hydroxide instead of the copper oxide commonly used. The surface must be thoroughly cleaned both before the test and between the dips. Even with these precautions, zinc coatings produced by different methods dissolve at different rates, for which an allowance must be made in comparing results. With care, this test will yield reliable results for the minimum thickness and distribution of the zinc coatings.

REVISED SIMPLIFIED PRACTICE RECOMMENDATION FOR TAPER ROLLER BEARINGS

Comparison of the list of sizes of taper roller bearings which appeared in the original draft of Simplified Practice Recommendation R67, approved at a general conference held in 1927, with the revised recommendation approved in 1933 and now available in printed form, shows the increasing use which industry has made of bearings of this type.

The original list, largely for automotive use, ranged in bore size from five-eights inch to 4½ inches. While there were many sizes within these limits, differing by small fractions, the fact that the maximum size was 4½ inches, indicates that bearings of this type were limited in application.

The current revision, known as Simplified Practice Recommendation R67–33, is evidence of the increasing field of usefulness of antifriction bearings. The acting chairman of the standing committee, Mr. E. Wooler, chief engineer of the Timken Roller Bearing Co., who also is vice chairman of the ball and roller bearing division of the Society of Automotive Engineers' standards committee, advised that the steep angle bearings up to 12 inches bore, which are added in the revision, provide for naval requirements, and for general industrial and automotive purposes.

In addition to the steep angle taper bearings, conventional bearings are divided in three series, light, medium, heavy. In the light series the bore sizes range from 0.375 inch to 3.750 inches. In the medium series the sizes range from 0.750 inch to 11.00 inches, and the heavy series, range from 1.00 inch to 12 inches.

In transmitting the revised recommendation, Mr. Wooler made the following explanation:

> The extended sizes in the medium series up to 11 inches and in the heavy series up to 12 inches were carefully worked out to our present-day knowledge, but they are not ready yet for standardization. However, their recommendation as simplified practice should assist considerably in making these bearings adaptable as a standard in the future. We already have a considerable number of large bore bearings and they will become as complicated as the original list of small bearings unless some such steps as the simplified practice scheme be adopted. The steep angle list is a selection of bearings in even increments from three-fourths inch up to 12-inch bore, which includes all the large production series in this type, although the number of other steep angle bearings is not so large as the conventional bearings.

Copies of this recommendation are obtainable from the Superintendent of Documents, United States Government Printing Office, Washington, D.C., at 5 cents each.

SIMPLIFICATION OF INDUSTRIAL TRUCK AND TRAILER SOLID TIRES

A proposed simplified practice recommendation covering industrial truck and trailer solid tires, cured-on-type, has been mailed to all interests in the industry by the division of simplified practice, of the Bureau, for their consideration and written approval.

This schedule, submitted by the standing committee of the industry in charge of the recommendation, if accepted, will be added to Simplified Practice Recommendation R103, In-

dustrial Truck and Trailer Solid Tires, Pressed-on-Type, recently revised and made effective from June 1, 1934.

CONFERENCE OF STATE UTILITY COMMISSION ENGINEERS

The twelfth annual conference of State utility commission engineers was held at the Bureau on May 31 and June 1. The conference was attended by engineers representing nine States and the District of Columbia. The program and arrangements for the conference were in charge of an executive committee consisting of the following utility commission engineers: Rudolph H. Nexsen, chief power engineer, Department of Public Service, New York, chairman; and Harry Barker, consulting engineer, Vermont; J. H. Wiley, chief engineer, North Dakota; P. L. Holland, chief engineer, Maryland; and G. C. Boyer, engineer, Virginia.

The following papers and discussions were presented: Customer and consumption data—residential customers, R. E. Purucker, electrical engineer, Wisconsin; load factor in relation to rates, Russell G. Warner, electrical engineer, Connecticut; use of indexes or cost translators in appraisals, Harry Barker, consulting engineer, Vermont; cost of electrical distribution, C. E. Bennett, engineer, Federal Power Commission; the taxicab situation, P. L. Holland, chief engineer, Maryland; and discussion, A. S. Bates, superintendent, motor-transport division, Connecticut; economies and improvements in rural telephone service, Harry Barker, Vermont; public-utility accidents—causes and prevention, L. G. Krause, chief engineer, Pennsylvania; butane and propane gases, W. M. Black, assistant chief engineer, Pennsylvania.

The proceedings of the conference are not published. A small number of copies of the papers is available, and copies will be sent to commission engineers so long as the supply lasts, upon application to the secretary of the conference.

The following executive committee was elected to make all arrangements for the annual conference of 1935: Harry Barker, Vermont, chairman; P. L. Holland, Maryland, vice chairman; E. H. Morris, West Virginia; J. H. Wiley, North Dakota; L. G. Krause, Pennsylvania. J. Franklin Meyer, National Bureau of Standards, Washington, D.C., is the secretary of the conference.

NEW AND REVISED PUBLICATIONS ISSUED DURING MAY 1934

Journal of Research [1]

Bureau of Standards Journal of Research, vol. 12, no. 5, May 1934 (RP nos. 676 to 684, inclusive). Price 25 cents. Obtainable by subscription.

Bureau of Standards Journal of Research, title page and contents to vol. 11, July to December 1933 (RP573 to 629, inclusive). Free on application to the National Bureau of Standards.

Research Papers [1]

[Reprints from March 1934 Bureau of Standards Journal of Research]

NOTICE.—Beginning with the July 1934 issue of this Journal the prices of the separate Research Papers appearing in each issue will be given at the conclusion of each separate paper.

This new arrangement provides a prompt and convenient method whereby readers desiring copies of separate Research Papers appearing therein may send their orders immediately to the Superintendent of Documents, United States Government Printing Office, Washington, D.C., and will aid him in determining the number of copies to be printed. The type is not held and there is but one edition.

RP653. Statistical investigation of the uniformity of grades of 1,000 Lovibond red glasses; G. K. Walker. Price 5 cents.

RP654. A method for the separation of ruthenium from platinum, palladium, rhodium, and iridium, R. Gilchrist. Price 5 cents.

RP655. Methods for the separation of platinum, palladium, rhodium, and iridium from one another and for their gravimetric determination, R. Gilchrist. Price 5 cents.

RP656. An examination of water from various natural sources for variations in isotopic composition, E. W. Washburn and E. R. Smith. Price 5 cents.

RP657. Some experiments with pure-metal resistance standards, J. L. Thomas. Price 5 cents.

RP658. Reproducibility of the ice point, J. L. Thomas. Price 5 cents.

[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D.C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $2.50 per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents and $3.25, respectively.

RP659. Kinetics of reaction between silver bromide and photographic sensitizers, B. H. Carroll and D. Hubbard. Price 5 cents.

RP660. Sources of error in measuring opacity of paper by the contrast-ratio method, D. B. Judd. Price 5 cents.

RP661. Errors in gas analysis arising from loss of gas by solution in rubber connections and stopcock lubricant, J. R. Branham. Price 5 cents.

RP662. Test of a flat steel-plate floor under loads, L. B. Tuckerman, A. H. Stang, and W. R. Osgood. Price 5 cents.

RP663. Portable detector for radium, L. F. Curtiss. Price 5 cents.

RP664. Determination of small amounts of zinc in steels and irons, H. A. Bright. Price 5 cents.

RP665. Thermal expansion of bearing bronzes; P. Hidnert. Price 5 cents.

Circulars[1]

C404. Cautions regarding gas-appliance attachments; J. H. Eiseman. Price 5 cents.

Simplified Practice Recommendations[1]

R67–33. (2d edition) Taper roller bearings. Price 5 cents.

Technical News Bulletin[1]

Technical News Bulletin No. 205, May 1934. Price 5 cents. Obtainable by subscription.

Letter Circulars

It is the intent of the Bureau to distribute single copies of these letter circulars on request only to those parties having special interest in the individual letter circular. Economy necessitates limitation in the number of copies issued. It is not the intent to supply parties with a copy of each letter circular issued during the month. Letter circulars are necessarily of a temporary nature designed to answer numerous inquiries on a given subject. Requests should be addressed to the National Bureau of Standards.

LC414. Antidimming preparations for glass surfaces.

OUTSIDE PUBLICATIONS[2]

Souder, Wilmer, Fifteen years of dental research at the National Bureau of Standards, Journal of the American Dental Association (212 East Superior St., Chicago, Ill.), vol. 21, p. 58, January 1934.

Paffenbarger, G. C., and Sweeney, W. T., A second survey of dental impression compounds and of inlay casting waxes, Journal of the American Dental Association (212 East Superior St., Chicago, Ill.), vol. 21, p. 657, April 1934.

Osborne, N. S., and Meyers, C. H., A formula for the saturation pressure of steam in the range 0 to 374 C, Mechanical Engineering (American Society of Mechanical Engineers, 29 West 39th St., New York, N.Y.), vol. 56, no. 4, p. 207, April 1934.

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